REVIEW OF RESEARCH
IMPACT FACTOR : 5.7631(UIF) UGC APPROVED JOURNAL NO. 48514 ISSN: 2249-894X
VOLUME - 8 | ISSUE - 4 | JANUARY - 2019

SPATIAL INEQUALITY OF URBAN FORESTRY: A STUDY OF KOLKATA MUNICIPAL CORPORATION (KMC)

Dr. Laxmi Narayan Saha
Asst. Prof., Department of Geography , Panihati Mahavidyalaya, Sodepur, Kolkata.

ABSTRACT :

Parks and gardens have been historically integrated with city designs. Ancient and medieval cities have made them as important as roads and buildings. As more and more people seek the option of living in towns and cities, the process of urbanization enhances the pressures upon the urban landscape. As a result, the quality of urban environment becomes increasingly poor. Green areas have important roles for towns and cities because they provide several environmental, social, cultural and economic benefits. But their benefits are sometimes overlooked and their management comes low in the list of priorities - both at the public and private arena. The present study is an attempt to study the spatial inequality in terms of distribution of parks and squares of Kolkata Municipal Corporation (KMC). Here the researcher applied Theil Index to know whether parks and squares are equally distributed over KMC or their presence is merely concentrated in certain enclaves within the study area. The researcher also focused on the temporal variation of inequality with reference to parks and squares over the years i.e. from 1951 to present. Although Theil index primarily used to measure economic inequality mainly in terms of income but here this index value is used to measure the inequality in terms distribution of parks and squares within KMC.

KEYWORDS : *inequality; spatial distribution, urban green, Theil index.*

INTRODUCTION

Research in the field of geography and mainly in urban geography has been contributing to the variable options that can contribute to the development of sustainable cities. Scarcity of green areas in cities is not an exclusively contemporary issue, but what is new, is the growing awareness among agencies of governance and citizens alike. Since 1970's, several key environmental issues have sought the attention of policy makers at the national and international levels. One such major environmental issue is urban forestry. Parks and gardens have been historically integrated with city designs. Ancient and medieval cities have made them as important as roads and buildings. As more and more people seek the option of living in towns and cities, the process of urbanization enhances the pressures upon the urban landscape. As a result, the quality of urban environment becomes increasingly poor. Urban forests have important roles for towns and cities because they provide several environmental, social, cultural and economic benefits.

Here the researcher tried to detect the spatial inequality with reference to distribution of urban forestry at Kolkata Municipal Corporation (KMC) in different census years starting from 1951 to 2011 with the help of Theil index. Here the spatial unit of investigation is KMC, the area of which has changed from time to time and presently it has 144 wards. Data on parks and squares were collected from

Kolkata Corporation Year Book of 1951, 1961, 1971, 1971, 1981 and 1991. Although in case of 1991 there are 41 wards i.e. from 101 to 141 for which no data on parks and squares were available. These data are exclusively of those parks and squares which were maintained by KMC. In absence of data on parks and squares for the year 2001, the same was collected from NATMO's DPMS of Kolkata by graphical method. These include all the private and public parks, vacant land, open spaces, burial ground etc. In case of 2011 the data on green areas of KMC have been calculated from satellite imagery (Resourcesat-1; Ortho:LISS-III, 2011, Resolution-23.5m). One of the key constrains of this part is that the jurisdiction of KMC has changed from time to time both in term of number of wards and area, rendering complications in temporal analysis. The present study evaluates whether urban green cover is equally distributed or its distribution merely concentrated in certain pockets of KMC.

URBAN FORESTRY: FUNCTIONS AND VALUES

Urban forest is one of the major trajectories of a sustainable urban environment. It provides habitat with great diversity of wildlife in the city. According to Wooley,2003 public parks as an important element of urban green areas have played a significant role that balances the needs for city conservation against degradation of urban environment while keeping the rapid urban development, unaffected. According to Deng et al. (2002), urban forests have the ability to significantly add to the beauty of urban areas. Urban forestry is defined as "the sum of all woody and associated vegetation in and around dense human settlements, ranging from small communities in rural settings to metropolitan regions" Miller,G.T. (1988). Urban forest includes natural and planted trees in streets, domestic yards, recreational areas, parks and gardens, unused public and private lands, transportation and utility corridors, open spaces, waste land, and watershed lands in and around urban areas. The excessive increase of population on the existing land use e.g. residential areas, cultivable land, roads, forestry, railways, industries etc. in the urban area have crossed all the previous levels in terms of resource utilization and it create environmental hazards. Urban forests have remarkable physical, social, economic values and it increase sustainability value to urban environment e.g. absorption of CO_2, reduction of storm water, energy conservation, huge property value, noise buffer, habitat for wild animals, enhance aesthetic value as well as place of recreation etc.

OBJECTIVES:

The present study intends to assess relevant aspects of spatial distribution of urban forestry in a temporal framework in KMC. Theil index is primarily used to measure economic inequality. But here in the present study the Theil index is used to explain the distribution pattern of urban green cover over time. In the present study the researcher tried to identify whether urban green cover are equally distributed all over the KMC or their presence is merely concentrated in certain pockets within KMC and also the temporal analysis reveals such distribution pattern over the years.

RESEARCH DESIGN AND METHODOLOGY

Inequality refers to a state or condition being unequal. It may be economic, social, environmental, physical etc. The present study deals with inequality in terms environmental parameter and here it is urban forestry. There are different methods to measure inequality e.g. variance, relative mean deviation, coefficient of variation, Hoover index, Atkinson index, Theil index, Gini coefficient etc. In the present study the researcher applied Theil index to measure the inequality in the spatial distribution of green cover within KMC.

Henri Theil's book on information theory (Theil 1967) provided a landmark in the development of the analysis of inequality measurement. Theil's measure is part of a special class of inequality measures known as Generalised Entropy, or GE measures. Derived from the concept of information theory, Theil's measure seeks to quantify the level of disorder within a distribution of income. The Theil index is the same as redundancy in information theory which is the maximum possible entropy of the data minus the observed entropy. Theil information-theoretic approach to the measurement of inequality is set in the context of

subsequent developments over recent decades. It is shown that Theil initial insight leads naturally to a very general class of inequality measures. It is thus closely related to a number of other commonly used families of inequality measures.

Although Theil index is mathematically very complex and mainly applied to get income inequality but the researcher here applied this generalised entropy inequality measures to quantify the level of unequal distribution in terms of an environmental parameter and here it is urban forestry of KMC. This study uses a secondary data procured from different sources e.g. Kolkata Corporation Year Book, NATMO's DPMS of Kolkata, satellite imagery (Resourcesat-1; Ortho:LISS-III, 2011, Resolution-23.5m) etc. The data collected from different sources were then analysed through statistical technique to show spatial as well as temporal variation.

STUDY AREA:

Most Indian cities today are facing huge population influx together with unplanned development. Rising urban population over the years, results in decrease in open space and greenery. Kolkata Municipal Corporation is selected for the present study located in the lower Gangetic delta and physiographically restricted by River Hugli in the west and by numerous wetlands in the east. Initially the expansion of KMC was in north-south direction but by the passage of time and with increase in population, KMC has witnessed large scale conversion of land for urban expansion and development in the eastern portion.

The total population of KMC as per 2011 census is 4496694. Presently KMC has 144 wards arranged within 15 boroughs. The largest green area of KMC spread over Maidan area which is supposed to be the lung of the city. Most Indian cities today are facing huge population influx together with unplanned development. Rising urban population over the years, results in decrease in open space and greenery. The megacity of Kolkata has been selected for this case study wherein green cover is decreasing day by day. This causes concern for the sustenance of the forest based ecosystem which provides several benefits for the city.

LIMITATIONS OF THE PRESENT STUDY:

Non-availability of official data on green cover posed limitations at different stages of the present study. Temporal distribution in terms actual coverage green area could not be done in a systematic manner as the area of KMC has changed from time to time. The study considers the period 1951 to 2011, and within this period KMC has changed its area and jurisdiction in the census years 1961, 1971 and 1991. KMC had only 32 wards in 1951. This was increased to 80 wards in the year 1961 followed by 100 wards in 1971. In 1984, after inclusion of neighbourhood municipal areas within the jurisdiction of KMC it has then 141 wards. This made issues of comparability, difficult. Data on vegetation cover of KMC were available from Corporation Year Book for the year 1951 to 1991.There is no official data on green cover for ward no. 101 to 141 for the year 1991. This led to data inconsistencies over time. Official data on green cover of KMC from 1951 to 1991 only refer to those parks and squares which were maintained by KMC. These data exclude all the private and public parks, vacant land, open spaces, burial ground etc. Secondary data on parks and squares are not available for the year 2001, 2011 respectively from govt. sources. In absence of data on parks and squares for the year 2001 and 2011, the same is collected from NATMO's DPMS of Kolkata as well as from satellite imageries. These include all the private and public parks, vacant land, open spaces, burial ground etc.

Inequality of Green Cover Distribution Using Theil Index:

The analysis presented here is based on the secondary data and maps collected from different sources such as KMC Year Book, 1951 to 1991, 2001; DPMS-Kolkata, 2001, Resourcesat-1; Ortho:LISS-III and Kolkata District Census, 2011. Here we study about the concentration of urban forestry within KMC over time i.e. from 1951 to 2011. The study evaluates whether urban green cover is equally

distributed or its distribution merely concentrated in certain pockets of KMC. The Theil index value helps us to explain such distribution over time. To calculate Theil index, following formula is used:

Theil Index: logN- E^{n}Xi log(1/Xi) where; x= Ward wise urban green cover in sq.m
Ex=Total urban green cover of KMC in sq.m
i=1
N= Total no. of wards
Xi=x/Ex

The value of Theil Index varies from 0-1, where 1 denotes concentration in certain areas while 0 refers to even distribution.

Table: 1 Theil index values on urban green cover: 1951 to 2011

Census Year	Total Green Cover of KMC (sq.m)	E^{n}Xi log(1/Xi)	Theil Index= logN - E^{n}Xi log(1/Xi)
1951	830839.40	1.244886877	0.153053131
1961	3745723.73	0.924115447	0.791887897
1971	3771660.57	0.79974803	0.978403221
1981	3765460.00	0.796663001	0.981488249
1991	3933770.00	1.298296766	0.588193959
2001	22445312.50	1.504814362	0.555883478
2011	25191900.00	1.691106362	0.419483348

Source: Prepared by author from KMC Year Book, 1951 to 1991; , 2001; DPMS-Kolkata, 2001, Kolkata District Census, 2011; Resourcesat-1; Ortho:LISS-III,2011District Census Handbook

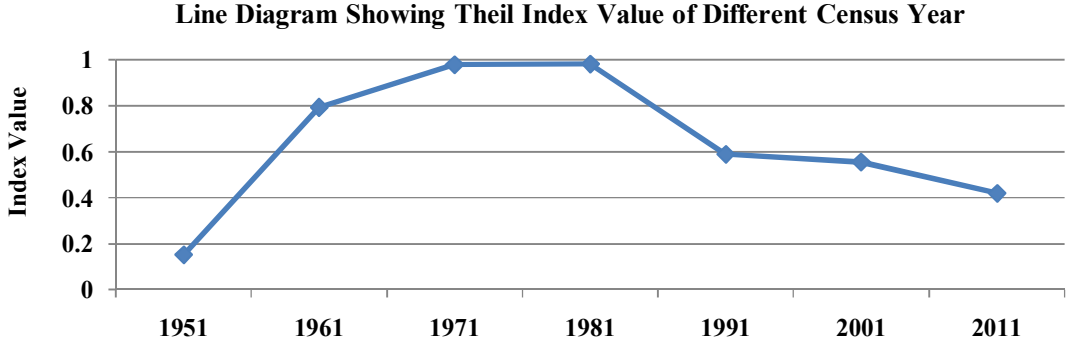

Fig: 1 Graph Showing Theil Index Value

Source: Prepared by author from KMC Year Book, 1951 to 1991; , 2001; DPMS-Kolkata, 2001, Kolkata District Census, 2011; Resourcesat-1; Ortho:LISS-III,2011District Census Handbook

In the year 1951 Theil's index value is 0.153053131 which means green cover was evenly distributed over KMC. Thereafter the scenario was totally changed. The values of Theil's index were 0.791887897, 0.978403221 and 0.981488249 in the census year 1961, 1971, 1981 respectively. It reveals that there was drastic change in the green cover in terms of concentrated distribution from even distribution as seen in 1951. After 1981, three municipalities were added within the jurisdiction of KMC. These are Garden Reach, South Suburban (Behala), and Jadavpur. As a result 41 wards were added within KMC. Because of inclusion

of suburban towns as well as less non built-up areas with open spaces, the index values decreases from 1991 (0.588193959). The same trend was found in the year 2001 (0.555883478) and 2011 (0.419483348). These may be on account of green awareness both at individual as well as administrative level.

MAJOR FINDINGS:

The present study focuses on the unequal distribution of urban green cover of Kolkata Municipal Corporation by analyzing the changes in spatio-temporal aspects over time, from 1951 to 2011. The major findings of the present study are as follows:

- In the year 1951 (32 wards) i.e. just after independence, green cover was evenly distributed over KMC.
- From 1961, the scenario was totally changed. Total ward number of KMC has increased to 80. Green cover distribution of KMC shows a drastic change in the green cover in terms of concentrated distribution from even distribution as seen in 1951. Same thing were happened in the year 1971and 1981 when ward numbers have increased to 100 wards.
- In the year 1984, three municipalities such as Garden Reach, South Suburban (Behala), and Jadavpur were added within the jurisdiction of KMC. As a result, 41 wards were added within KMC. The inclusion of suburban towns as well as less non built-up areas with open spaces, the index values decreases from 1991 onwards. This implies a gradual increase in the even distribution of urban green cover.

CONCLUDING REMARKS:

Forest cover enhances quality of life of city dwellers. The growth and expansion of urban area continues in almost all the developing countries resulting in negative impact upon the urban environment. Kolkata, former capital city of India, presently the capital of West Bengal is a city where rapid urbanization continues to result in ecological degradation evident from reduction in green cover. Urban environment of Kolkata can be protected through tree plantation in open space, and restoration of existing urban green areas. Urban environment with luxurious vegetation cover provides huge benefits. Parks and squares, avenue trees etc. are crucial for augmenting the quality of life of urban people as well as sustainable urban management.

On account of congested, built-up area mainly in the central portions or older Kolkata, the shares of green cover in those areas have gradually and significantly decreased. Topographical maps (79B/6 and 79B/7) of Kolkata for the year 1958-1960 show continuous built-up area in the central and northern part of Kolkata whereas the eastern, south-eastern, southern and south-western parts are occupied by either water bodies or vegetation cover. DPMS of Kolkata for the year 2001 also shows luxurious green cover in and around eastern, south-eastern, southern and south-western parts. Northern and central portion of Kolkata are mainly occupied by residential, commercial, mixed residential-commercial land use. Also land use and land cover map of KMC based on Resourcesat-1;Ortho: LISS-III shows that maximum concentration of green cover are found near western, south-eastern, southern, south-eastern and eastern parts. Total Urban green cover of KMC has been increased since 2001 and this was mainly due to the addition of sub-urban municipalities within the jurisdiction of KMC as well as due to the inclusion of all sorts of green cover whether it is public or private. Therefore, it is also evident from Theil index that spatial distribution of green cover which showed a even distribution in the year 1951 (Index Value-0.15) turned into concentrated distribution (Index Value-0.98) in the year 1981. But there after the scenario has been changed (Index Value-0.42 in the year 2011) due to initiatives both form Govt. level as well as private level as well as inclusion of sub-urban municipalities.

ACKNOWLEDGEMENT

This paper is a part of my doctoral thesis submitted at University of Calcutta, India, under the supervision of Prof. Sumana Bandyopadhyay. I gratefully acknowledge her guidance and constant support along with valuable suggestions and comments.

REFERENCES

1. Atkinson, Anthony B.: *On the Measurement of Inequality*, in: Journal of Economic Theory, 1970, Vol.2, pp. 244 –263
2. Deng, X., Liu, J., Zhuang, D., (2002): "Modeling the Relationship of Land Use Change and Some Geophysical Indicators: a case study in the Ecotone between Agriculture and Pasturing in Northern China", *Journal of Geographical Sciences*, Vol. 12, No. 4, pp. 397–404.
3. Kakwani, N.C., *Income Inequality and Poverty: Methods of Estimation and Policy Applications*, Oxford University Press, New York, 1980.
4. Konijnendijk,C.C., Ricard,R.M., Kenney,A. and Randrup,T.B. (2006): Defining urban forestry-A comparative perspective of North America and Europe, Urban Forestry and Urban Greening, Elsevier, Vol.4,Issue.4, pp.93-103.
5. Miller,G.T.(1988): Living in the Environment, Wadsworth,6th ed., Belmont, California.
6. Miller,R.W.(1997): Urban Forestry: Planning and Managing Urban Green Spaces, Second Edition, Prentice Hall, New Jersey.
7. Theil, H., *Economics and Information Theory,* Amsterdam, North Holland, 1967.
8. Woolley, H. (2003): Urban Open Spaces. Spon Press, London.

Dr. Laxmi Narayan Saha
Asst. Prof., Department of Geography, Panihati Mahavidyalaya, Sodepur, Kolkata.